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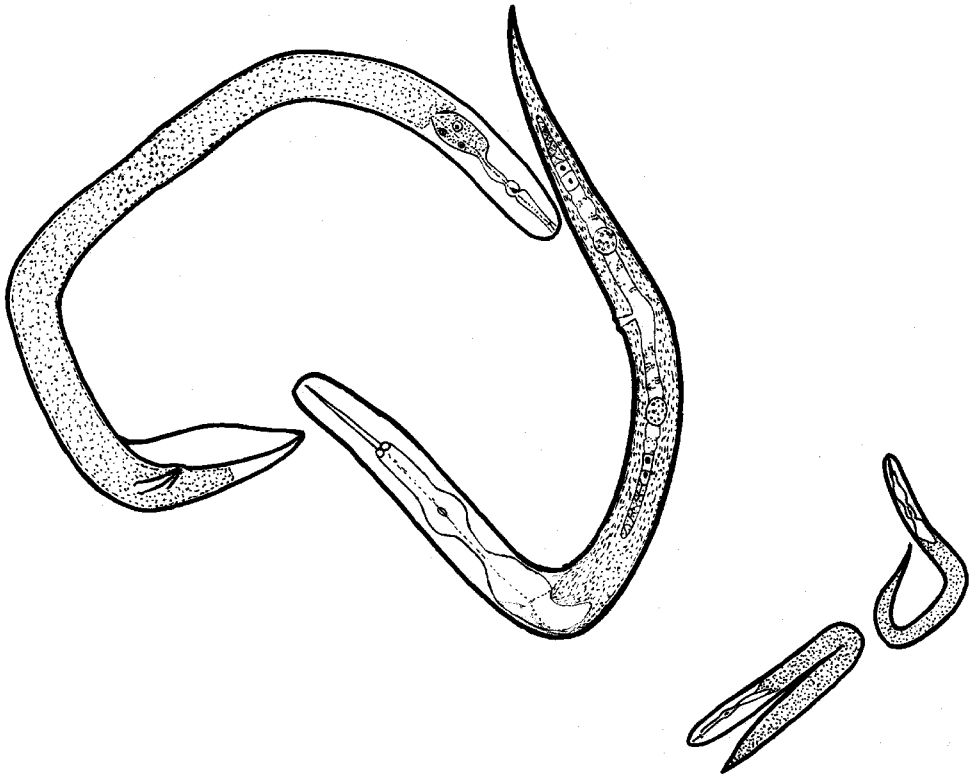
AUSTRALASIAN NEMATOLOGY NEWSLETTER



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From the Editor

Thank you to all those who made contributions to this newsletter.

January Issue

The deadline for the January issue is December 1st. I will notify you a month in advance so please have your material ready once again.

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Association News

FROM THE PRESIDENT

Nematodes have actually been in the news a bit of late. First there was an incursion of an undescribed species of *Bursaphelenchus* near Melbourne. Then there were some less serious incursions of different species, all caught by quarantine staff. For those of you unfamiliar with the genus *Bursaphelenchus*, they are related to the leaf and bud nematodes *Aphelenchoides* spp., and kill coniferous trees mainly through obstruction of the vessels in the bole. They are carried by beetles from tree to tree and caused very serious damage in parts of Asia when they were introduced accidentally. The story made the Melbourne Sun newspaper, which is unusual given that publication's primary focus on sport. The interest may be unusual, but it is not the first time a story on nematodes was published in that newspaper, as I was sent an article about a nematode that lives in beer mats some time ago.

The potential incursion of exotic nematodes of course raises the issue of how little we know about the species already occurring here. This is one of the reasons that nematode collections exist, including the ANIC collection which I oversee. When there are nematodes sent to me which may be exotic, the collection is an invaluable resource to be able to check and compare with what has already been found in Australia. To fulfil this role it is important that the collection be as comprehensive as possible, so we are always looking for interesting specimens, in whatever state of preservation, from everywhere in Australia. All records and specimens help build a picture of the distribution of species within the country, which can also be very useful. I can always be contacted regarding this or any other queries about the collection at the address given in the bulletin or the society's web page.

I was interested to see some exchange of correspondence on the nematode e-mail list run by the University of Nebraska, Lincoln. The discussion was on the state of nematology in different places in the world. It seems that support for nematology could be improved in a number of places in the world, Australia amongst them. This is already featuring in discussions of the International Federation of Nematology Societies, of which AAN is a member. One of the aims of the Federation is to raise the profile and support of nematology worldwide. In these discussions, the ideas and experience from other places will, I am sure, enhance the ability of myself and others in AAN to better inform those making decisions on funding of the value of our science. I will summarise useful points in a future column: very handy for grant applications.

There have been many expressions of interest in the 1 week course on "Nematodes & cropping systems: identification & techniques" in Canberra in December 2001. Those interested should register their interest as soon as possible because the course is limited

to 15 participants. This limit allows highly individual attention to all participants, and the best cross-fertilization of experience from the differing experiences of dealing with nematodes.

With this level of interest, one would think that the funding for nematology would be on a firmer basis than it is currently.

Iqbal Zahid, working on nematodes in white clover for a PhD with CSIRO Canberra and with others at the Orange Agricultural College of the University of Sydney, submitted his thesis recently and is now working at NSW Agriculture at Wagga Wagga. Sadly, Iqbal is now working on fungi rather than nematodes, but may return to nematodes in the future. Look out for the papers in APP: there were some interesting findings regarding the relative importance of various species of plant-parasites.

The biennial meeting of the society will, as usual, be held in conjunction with the Australasian Society for Plant Pathology, in September in Cairns. I hope as many people as possible will make the sacrifice to travel to this inhospitable place. (Personally, I prefer the minus 2 degrees and fog of a Canberra winter morning!?!)

As foreshadowed in the last newsletter, the nematode keys on the web are now operational. Have a look at them and the other information on the world wide web at:

www.ento.csiro.au/science/nematode

There is a key to *Pratylenchus* as well as aquatic nematodes, and other information on nematodes. The key will be expanded to cover other nematodes and more pictures added as resources permit.

Mike Hodda

NEMATOLOGY WORKSHOP AT 13TH APPS CONFERENCE

Organisation for the nematology workshop for the 13th Australasian Plant Pathology Conference in Cairns is well underway. The workshop will focus on how to use the diversity of free living nematodes in the soil to determine the sustainability of agricultural management. The workshop will be run by Dr. Gregor Yeates from Landcare Research in New Zealand. It should be a very informative workshop and a great opportunity to find out what those other nematodes are that you get in your samples. The workshop will be a hands on session and very worthwhile attending.

The workshop will be held on Monday 24th September 2001, at the Queensland Department of Primary Industries Centre for Wet Tropics Agriculture located about 90 km South of Cairns. A bus will be available to pick up all participants in the workshop and transport them to the workshop and then back to Cairns in time for the welcoming reception. Therefore, it is important that all participants to the workshop give me their accommodation details to make sure they are picked up. There will be more information about this being e-mailed out to people who register for the workshop.

As part of the conference and workshop, a dinner has been organised for Tuesday night 25th September 2001. This will be at *Windows to the Reef*, located in the Pier Market Place complex in Cairns. As well as superb seafood the restaurant has excellent views of the Cairns Marina area. The cost of the dinner is included in the workshop registration costs.

If you have not registered for the conference or the nematology workshop time is running out with early registrations closing on 2nd August 2001.

If you need more information please contact me.

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WELCOME TO NEW AAN MEMBERS

We would like to welcome 3 new members to our association. Imelda Soriano and Diand Walter both from South Australia and Sosamma Mathai Pazhavarical from New South Wales.

JOINT MEETING NOTICE

The Joint Meeting of the American Phytopathological Society, the Mycological Society of America and the Society of Nematologists is to be held from 25th -29th August 2001, at the Salt Palace Convention Center in Salt Lake City, Utah. Go to www.apsnet.org/meetings to get full program information.

EBBE S NIELSEN

We regret to inform you of the death on 7th March 2001, of our long standing member Ebbe S Nielsen. For further advice please contact Anne Grubb, Personal Assistant. Anne.Grubb@ento.csiro.au

Regional News

NEWS FROM SOUTH AUSTRALIA

Adelaide Univesity, Applied and Molecular Ecology

The group has grown with the addition of Imelda Soriano, Caroline Versteeg and Tara Sallows. Imelda has come from International Rice Research Institutive in the Philippines with an international scholarship awarded by Adelaide University. She is studying towards a PhD in plant chemical defences against nematodes.

Caroline has joined the team at a distance and will be studying towards a Masters degree while in Cairns. She will be working on brassicas and root knot nematode under the local guidance of Tony Pattison (QDPI).

Tara is well into her Honours project with Mark Potter examining glucosinolates and *Pratylenchus* in canola-quality mustards.

Sharyn Taylor is congratulated for successfully completing her PhD - examiners satisfied, now she must patiently wait for graduation in December.

Kerrie Davies has been on two more field trips collecting *Fergusobia* and enjoying the scenery in North Coast NSW and the East Kimberley WA. The best nematodes are always found in the most scenic places.

Mark Potter has disappeared on an international study tour, working in labs in Canada and USA and presenting papers at conferences in Canada and Malaysia.

We bid farewell to Terry Bertozzi who has left the Waite Campus for the heady heights of the elite North Terrace institutions. Terry has taken a position with the South Australian Museum involved in curation to the animal tissue collection.

Speakers at our campus-wide nematode discussion group for first semester were Kerrie Davies on snails and fergs in the wilds of the west, Imelda Soriano on rice nematology, Robyn Van Heeswijck and Tricia Franks (HVO, Adelaide University) on *Phylloxera* and RKN and vines and Sharyn Taylor (SARDI) on *Ditylenchus*. If you're planing to visit Adelaide, please give us ample warning as we would love to have you on the list for second semester.

Ian Riley, The University of Adelaide

NEWS FROM NEW ZEALAND

More news from the most southerly nematologist in the World (I think!)

As usual I am continuing with my own eclectic mix of nematology, parasitology and environmental physiology (with a bit of entomology thrown in). Brent Sinclair has been awarded his PhD on the Ecology of NZ Alpine and Antarctic Arthropods and Norm Davis has been awarded his PhD on Cercarial Dermatitis and Biological Control in Lake Wanaka, NZ. I've also had or have students working on lungworm in deer, *Anisakis* in fish processing and cold tolerance mechanisms of alpine cockroaches. Debbie Thomson is starting an MSc project looking at nematophagous fungi and trichostrongyle nematodes.

Gordon Goodall has joined my lab as a postdoctoral fellow working on a Marsden fund project looking at ice-active proteins in Antarctic nematodes (*Panagrolaimus davidi*). This nematode is the only organism known to survive intracellular freezing. It produces a protein (or proteins) that controls the stability of ice in their bodies (and perhaps other characteristics of ice that are involved in surviving intracellular freezing). Gordon's main task at the moment is to isolate, purify and sequence the protein involved. Apart from this project, I'm also keeping an interest in anhydrobiosis in nematodes. My book (*Life at the Limits: Organisms in Extreme Environments*) is in press with Cambridge University Press.

I am organising the Annual Meeting of the New Zealand Society for Parasitology, to be held here in Dunedin in November of this year. Plant nematologists are welcome - let me know if you'd like to come.

David Wharton

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http://www.otago.ac.nz/Zoology/Index.html

NEWS FROM QUEENSLAND

For those of you who haven't heard, Dr. Julie Stanton has retired from nematology and her position with QDPI in Brisbane to further her studies. Julie is studying full time for a Masters in Industrial Property on line from the University of Technology Sydney. When Julie has completed this course, hopefully after one year, she hopes to resister as a Patent Attorney.

Jenny Cobon.

MORE NEWS FROM QUEENSLAND

Leslie Research Centre, DPI

Nikki Seymour has returned to full-time work on a GRDC-funded project - "Inheritance of new sources of resistance to *Pratylenchus thornei* in wheat". She has several promising lines from the Middle East that she hopes to incorporate into the wheat-breeding program.

Rebecca Zwart is in the last 6 months of her PhD, which appears to have progressed very smoothly with a great deal of hard work. She is looking forward to beginning a new project with the Northern Wheat Molecular Marker Project (a collaboration between DPI, CSIRO and University of Southern Queensland) on multiple disease resistance of wheat. Rebecca will be seeking molecular markers for resistances to *P. thornei* and *P. neglectus* and yellow leaf spot.

Jason Sheedy is looking forward to the release, hopefully next year, of the wheat variety, based on GS 50a, that is very tolerant to *P. thornei*.

Tim Clewett continues to be indispensable to all of our projects. He reports that there were very successful wheat and chickpea variety trials last season. His current project is a divine one – "making it rain so we can plant some field experiments this winter".

Ros Reen's work on chickpea resistance to *P. thornei* and *P. neglectus* continues to produce some promising results using wild relatives. These resistances are being incorporated into the best yielding chickpea varieties with other disease resistances as part of the National Chickpea Improvement Program.

John Thompson attended the Soil Borne diseases symposium earlier this year. He presented a paper on one of the downsides of trying to use Canola in rotations to control *Pratylenchus thornei.* Canola is not a host of arbuscular mycorrhizal fungi resulting in poor growth of following wheat on low phosphorus soil. Julie Nicol visited recently before taking up her new role in Turkey with CIMMYT to discuss half diallel crosses for assessing the genetics of resistance to *P. thornei* in wheat.

I have returned to work part-time after having a short break to have a baby last year. Michelle O'Reilly worked on the "Cropping Options" project while I was away. We have some good results from glasshouse experiments using summer and winter crops inoculated with *P. thornei*. Most summer and winter crops are poor hosts, but a black gram variety Regur and several triticale varieties had quite high populations of *P. thornei* 15 weeks after inoculation. We also observed an interesting interaction of VAM, *P. thornei* and canola in some field experiments presented by John Thompson at the Soil-borne Disease Symposium in Lorne and the International Conference on Mycorrhiza 3 in Adelaide.

Kirsty Owen

Research

MYCORRHIZA AND BURROWING NEMATODES ON BANANAS

Tony Pattison,

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Introduction

Burrowing nematode (*Radopholus similis*) is the most destructive nematode on bananas worldwide. The nematodes are currently managed in banana crops with chemical nematicides. The nematicides are expensive, toxic and becoming less effective due to enhanced biodegradation.

To avoid spreading nematodes in vegetative planting material, the use of tissue cultured banana plantlets to start new plantations is increasing. Sucker derived plants were less sensitive to nematode infestation compared to tissue cultured plants (Blomme 2000). It has been shown that tissue cultured plantlets are also more susceptible to Panama disease (*Fusarium oxysporum* f.sp. *cubense*)(Smith *et al* 1998). This could be due to the sucker derived material having an associated microflora, whereas, tissue cultured banana plantlets being taken from a sterile environment, have very limited microflora when placed in the soil.

It has been shown that plants infected with mycorrhiza have increased resistance to pathogens, increased tolerance to abiotic stress, and improved phosphate uptake (Sikora 1992). Endomycorrhizal fungi, living within the plant roots, limit the densities of plant-parasitic nematodes on a broad range of host plants (Sikora 1992, Pinochet *et al* 1996, Lopez *et al* 1997). Mycorrhiza reduced the number of *Radopholus similis* on the roots and soil, and reduced the formation of necrotic lesions within banana roots (Umesh *et al* 1988). Similar results were obtained with other nematode species reducing the number of *Meloidogyne* spp. and *Pratylenchus goodeyi* in the roots of banana plants (Jaizme-Vega and Pinochet 1997, Pinochet *et al* 1997).

Inoculation of bananas with either mycorrhizal fungi *Glomus mossease* or *G. geosporum*, resulted in significantly higher shoot fresh and dry weights as compared to control plants (DeClerk *et al* 1994). The better growth of mycorrhizal plants is attributed to a more efficient exploitation of soil mineral resources, principally phosphate and also bioprotective effects through enhanced tolerance/resistance to soil-borne pathogens like nematodes (Gianinazzi-Pearson 1997). Bananas respond well to mycorrhiza infection and have been shown to develop larger root systems and have higher N, P and K contents in the leaves than non-mycorrhizal plants (Umesh *et al*

1988). However, in the presence of the nematode, internal spore production by micorrhizae were significantly reduced (Pinocet *et al* 1997).

There have been a number of investigations on the use of endomycorrhiza as a biological suppressant of migratory endoparasitic nematodes as both organisms occupy the same ecological niche within the cortical tissue of the host roots (Pinochet *et al* 1996). The aim of the trial was to determine if mycorrhizal infection of banana roots is able to reduce the damage caused by burrowing nematode.

Materials and methods

Mycorrhizal inoculum

The inoculum was prepared by growing corn seedlings (*Zea mays* cv Supersweet) in soil, which was previously found to have a high mycorrhizal infection. The corn seedlings were grown for 6 weeks before being washed from the soil. The roots were dipped into 0.1 % streptomycin sulfate for 1 minute and allowed to air dry in order to reduce bacteria that may be associated with the roots. The corn roots were stained with acid fuchsin to confirm the presence of mycorrhizal infection. Banana plants were inoculated with mycorrhizae-infected corn roots by placing the chopped root pieces in the soil when potting the tissue cultured plantlets.

Treatments

Tissue cultured banana (cv Williams) plantlets were potted into 1.5 kg of pasteurised krasnozem soil. Four treatments were imposed on the plants for the trial.

1. mycorrhizae plus nematodes
2. mycorrhizae only
3. nematodes only
4. control (no nematodes and no mycorrhizae)

The treatments were replicated ten times in a randomised block. Mycorrhiza were added in treatments 1 and 2 at potting. Banana plants in treatments 1 and 3 were inoculated with 1135 motile burrowing nematodes 27 days after potting. The nematodes were added in 1 mL of water applied to the soil surface. The pots were than watered with 20 mL of water to incorporate the nematodes into the soil.

Plant growth

Measurements of leaf emergence and plant height occurred at inoculation with mycorrhiza and at 33, 57 and 98 days after potting. The trial was concluded 98 days after inoculation with measurements recorded for the size of the last fully emerged leaf, plant dry weight, corm weight and root fresh weight. Sap was extracted from the tops of banana plants by compressing the tops in a cylinder with 5 mm diameter holes at the base. The sap was collected and frozen until required for nutrient analysis. The cylinder was rinsed thoroughly between samples to remove all traces of plant material and sap. The banana sap was analysed for nutrient analyses using a Merck Reflectoquant meter (Merck, Kilsyth Victoria) with tests for nitrogen, phosphorus and potassium.

Mycorrhizal assessment

At harvest of banana plants, eight 1 cm pieces of the primary root were taken approximately 10 cm from the corm. Four root pieces were stained for mycorrhiza using the method described by Baker and Gowen (1996) using acid fuchsin. Four were stained with trypan blue (Fyson and Oaks, 1992). Staining involved dipping the root pieces in hot (90^{o}C) 7.5 % potassium hydroxide for 45 minutes. The root pieces were then rinsed under tap water for 1 minute and transferred to hot (90^{o}C) 1 % HCl for 15 minutes. The root pieces were then placed in hot staining solution for 1 minute, of either acid fuchsin (1 g acid fuchsin dissolved in 500 mL lactic acid, 250 mL glycerol and 250 mL of water) or trypan blue (0.5 g trypan blue in 400 mL glycerol, 333 mL lactic acid and 267 mL of distilled water). The root pieces were rinsed with running tap water for 1 minute and then destained using a solution identical to the staining solution but without the stain. Root pieces were stored in glycerol acidified with a few drops of HCl until they were examined for the presence of mycorrhiza (no more than 14 days).

The roots were assessed for mycorrhiza by placing four root pieces between two glass slides and examining the root pieces for presence or absence of external hyphae, vesicle and arbuscles. Scores were given to each root for hyphae, vesicle and arbuscles; 0 if absent, 1 if present and 2 if abundant on the root surface. An index was then calculated dividing score of four pieces (one replicate) by 8, the maximum possible score if all roots had abundant mycorrhizal features on the root.

Nematode assessment

The remaining root system was chopped into 1-2 cm pieces and nematodes extracted, by placing the chopped root pieces into a misting chamber for 7 days. After the seven days the nematodes were collected on a 25 μm sieve and counted under a compound microscope.

Data was analysed using standard analysis of variance techniques and means were separated using the least significant differences for 5 per cent probability. Nematode counts were normalised using a ln(x+1) transformation prior to statistical analysis. Genstat 5, version 3.2 was used for all data analysis and means separated using the LSD only if found to have significant differences in the AOV.

Results and discussion

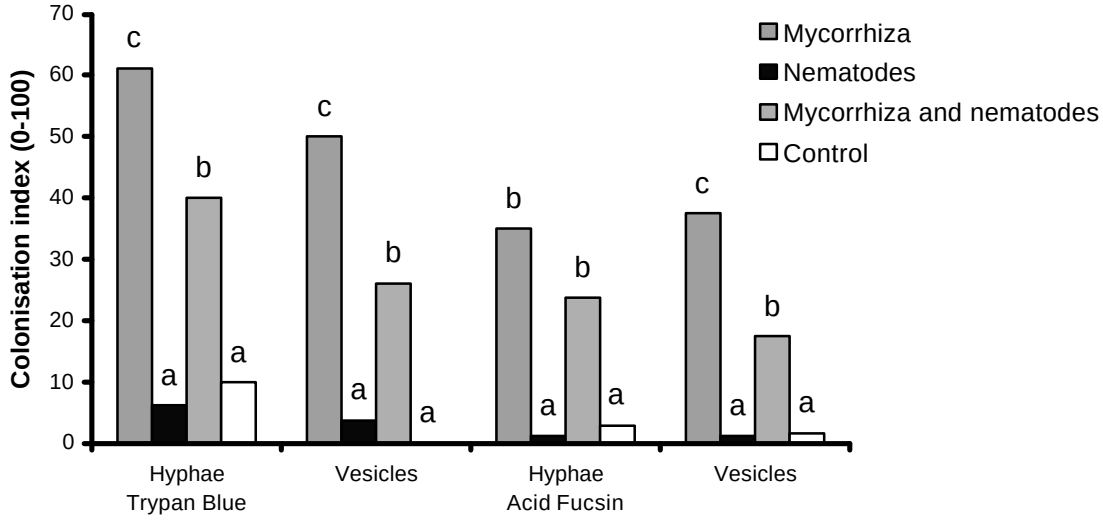
Plant growth

There was no significant increase in leaf emergence or plant height in any treatment over the 98 days of the trial (data not shown). Similarly, at the completion of the trial there were no significant differences in the growth of plants, measured by the leaf area of the last fully emerged leaf, shoot dry weight and the fresh weight of the roots and corm (data not shown). This is in contrast to results obtained by other researchers (Jaizme-Vega and Pinochet, 1997, Pinochet *et al*, 1997, Declerk *et al*, 1994, Declerk *et al*, 1999 and Umesh *et al*, 1988). This may be due to differences in soil phosphorus levels. The soil used in this experiment had adequate phosphorus levels (108 mg/kg) and was unlikely to respond to phosphorus fertilisation (J. Armour pers comm.). This may have meant that mycorrhiza infection of roots was not necessary for plant vigour as the plants were able to achieve adequate nutrients from the soil. Since this soil is typical of the soils in the north Queensland banana growing area, mycorrhiza infection of tissue

culture plants with may not cause an increased in the growth compared to plants with no mycorrhizal infection.

Mycorrhizal assessment

Mycorrhizal features were significantly more abundant on plants which were inoculated with mycorrhiza but had no nematodes (Figure 1). The presence of burrowing nematodes in the roots of banana plants reduced mycorrhizal infection. This is consistent with reports which found that mycorrhizal fungi were negatively affected by migratory endoparasitic nematodes due to the destruction on the cortical tissue of the root (Umesh *et al* 1988 and Pinochet *et al* 1996). Not surprisingly, there were significantly reduced mycorrhizal features on the roots which were not inoculated with mycorrhizae infected corn roots (Figure 1). There was little difference in the two stains used to assess mycorrhizal infection of banana root pieces. Both stains identified



external hyphae and vesicles on the root surface. However, neither staining method was able to highlight the presence of arbuscles in the roots. The arbuscles may have been destroyed during the clearing and staining of the roots with KOH.

Figure 1. Assessment of the mycorrhizal hyphal and vesicle colonisation of the roots of tissue cultured banana plants stained with two stains and inoculated or uninoculated with mycorrhiza and inoculated with *R. similis*.

Nutrient assessment

Significantly more phosphate was found in the sap of banana inoculated with only mycorrhiza than any of the other three treatments (Table 1). The increase in phosphate is consistent with increased mycorrhizal colonisation of the roots. Mycorrhiza have long been associated with increased uptake of phosphorus (Schenck 1982), but some reports have also shown increased N and K in the leaves of banana plants (Umesh *et al* 1988; Blomme *et al* 2000), while Pinochet *et al* (1997) found a decrease in the amount potassium in the leaves. There were no significant differences in the levels of nitrate and potassium in the sap between the four treatments in this trial (Table 1).

Table 1. Banana sap nitrate, phosphate and potassium levels in plants inoculated and uninoculated with mycorrhiza and inoculated and uninoculated with *R.similis.*

Treatment	Nitrate (mg/L)	Phosphate (mg/L)	Potassium (g/L)
Mycorrhiza	360.3	107.5 b	2.1
Nematodes	294.9	44.5 a	1.82
Mycorrhiza and nematodes	241.5	58.5 a	1.93
Control	195.5	50.5 a	1.96
P (0.05)	ns	*	ns

All numbers are the means of 10 replicates. Numbers with different letters following are significantly different from one another using LSD at $P = 0.05$. ns represents no significant difference at P=0.05.

Nematode assessment

There were significantly more burrowing nematodes recovered from the roots systems of banana plants without mycorrhizal colonisation than with mycorrhiza (Table 2). The presence of endomycorhizae in the roots of bananas has been reported to reduce number of burrowing nematodes (Umesh *et al* 1988) and reduce, lesion formation caused by *P. goodeyi* (Jaizme-Vega and Pinochet 1997). However, the number of lesion nematodes or root-knot nematodes was not significantly different on mycorrhiza and non-mycorrhizal infected banana roots (Jaizme-Vega and Pinochet 1997 and Pinochet *et al* 1997). This suggested that the effects that mycorrhiza may have on nematodes may depend on the time of infection by mycorrhiza relative to penetration by nematodes and may be an inconsistent method of reducing nematode protecting plants from nematode attack.

Table 2. Transformed (In (x+1)) nematode numbers recovered from the roots of banana plants inoculated with mycorrhiza and nematodes.

Treatment	*Radopholus similis* per plant		
Mycorrhiza	0.00	a	(0)
Nematodes	4.04	c	(149)
Mycorrhiza and nematodes	2.19	b	(42)
Control	0.26	a	(1)
P=0.05	*		

All values are the means of 10 replicates. Numbers in brackets are back transformed means. Numbers with different letters following are significantly different from one another using LSD at $P = 0.05$.

Conclusion

While the phosphorus levels in banana plants increased from infection with mycorrhizal fungi, there was no increase in plant growth. There was, however, insufficient evidence to support the use of mycorrhiza as an inoculant to prevent burrowing nematodes damage on tissue cultured bananas. Mycorrhiza and burrowing nematode seemed to exhibit an antagonistic effect on each other. Nematode numbers were reduced in plant infected with mycorrhiza. Also, colonisation of mycorrhiza on the roots was reduced in the presence of nematodes, possibly due to reduced cortical tissue caused by nematode feeding.

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Review

BIOFUMIGATION AND MANAGEMENT OF NEMATODE INFESTATION IN VINEYARDS

Charles Sturt University, Wagga Wagga, 2000

Summary of Rod McLeod's PhD thesis

Brassicaceae crops are considered to have potential for pest and disease control due to constituent glucosinolates, chemicals that on hydrolysis form biologically active compounds, particularly isothiocyanates. The impact of release of these actives from Brassicaceae crop residues has been termed biofumigation. The project's aim was to investigate the potential and problems of using Brassicaceae as inter-row green manure crops for control of *Meloidogyne* in vineyards. The sub-title was "Studies on the host parasite relationships of *Meloidogyne javanica* and crop species of the family Brassicaceae".

Brassicaceae green manures incorporated in soil reduced activity of *Meloidogyne javanica* J2; incorporation of 40g/kg soil suppressed J2 recovery by 90 percent. Although correlation between effect and glucosinolate addition was weak, results showed that green manures with high total glucosinolate concentrations or high levels of particularly toxic glucosinolates were more effective. Fodder rape cultivars with high glucosinolate levels were identified as worth further attention, so were Indian mustards, oilseed radishes and fodder kales, because of the particular glucosinolates they form. Future research should focus on increasing total glucosinolate concentrations and on manipulating glucosinolate types. Suppression was also shown with very low glucosinolate additions, indicating suppression not related to glucosinolate effects.

M. javanica reproduced, with a reproduction factor of two or greater, on 21 of 25 Brassicaceae cultivars possibly suitable for use as inter-row crops in vineyards. Of these 21, Gruner kale supported least egg production. Reproduction factors were less than one on four oilseed radishes, namely Adagio, SCO 7024, Nemex and Pegletta. Egg production on all Brassicaceae cultivars was lower than on tomato. The conclusion was drawn that Brassicaceae crop species are generally intermediate rather than good hosts of *Meloidogyne*. No simple association was found between egg production and glucosinolate concentrations in roots of uninfected 3-month-old plants. The possible role of dehydroerucin (4-methylthio-3-butenyl) in the low host status of Adagio oilseed radish is noted.

Identification of *Meloidogyne* populations from vineyards by perineal pattern, by diagnostic host range tests and by mtDNA sequencing gave differing results. Perineal pattern identification indicated three species, *M. arenaria, M. incognita* and *M.*

javanica, while host range tests suggested only one, which could be either *M. arenaria* race 2 or *M. javanica*. mtDNA sequence suggested two *Meloidogyne* entities, *M. arenaria* and *M. javanica*. Populations representing the range of perineal pattern and mtDNA diversity showed similar host preferences on the commonly grown inter-row crops Brumby ryegrass, Coolabah oats, Cooba oats, Kopu white clover and the Brassicaceae Rangi rape, Adagio oilseed radish and Polybra turnip. This commonality of host range simplifies management of *Meloidogyne* infestation by selection of poor host inter-row crops.

It was found that Brassicaceae crop species are in general less invaded than good hosts and that this at least is partly responsible for their intermediate host status. Reduced invasion lowers risk of infection in the field. Brassicaceae crops also suppressed the in-host phases of *Meloidogyne* parasitism. Suppression was expressed in slower development of the parasite, lower in-host populations, retarded growth of females and reduced egg laying. Reduced invasion and decreased egg production both contribute to reduced host status. Hypotheses are advanced to explain a possible role for the glucosinolate/isothiocyanate system in suppressing *Meloidogyne* parasitism.

Further experiments investigated the impact of crop management factors such as treatment of seed with nematicide, sowing time, slashing, application of glyphosate and time of crop incorporation on nematode reproduction. Mustard seed meal inserted in soil around newly infested vines in pots reduced vine infestation but meal treatment of long-infested vines in the field gave no clearly significant effect. Biofumigation is considered unpromising for elimination of *Meloidogyne* already established in grapevine roots.

Inter-row crop selection and management, including sowing of Brassicaceae crops, is seen as part of an integrated approach to minimizing the impact of nematodes in vineyards and an overall strategy is outlined. The general discussion also considers passive resistance of plants to nematodes due to constituent defence chemicals. It is suggested that the co-incidence of Brassicaceae and *Meloidogyne* is recent and any impact of the glucosinolates on host-parasite relations is probably coincidental.